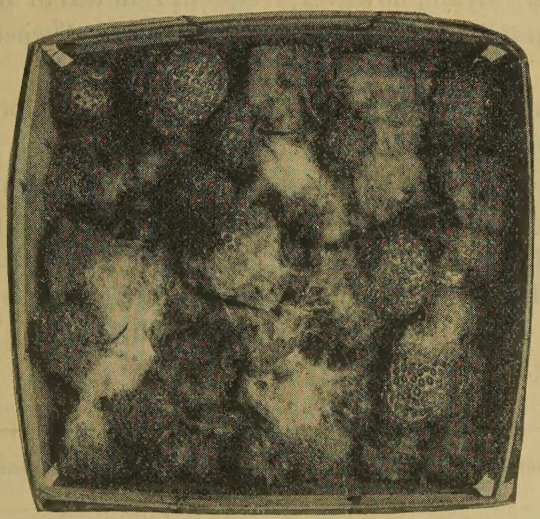
1925

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1458

STRAWBERRY DISEASES



28 DEC. 1932

12·11·25

THE GREAT VARIETY of conditions under which the strawberry is grown necessitates different methods of culture and handling. Methods of control of strawberry diseases must be adapted to local conditions.

Severe attacks of leaf diseases—leaf-spot, scorch, and mildew—are best controlled by spraying or dusting. Often, however, frequent renewal of strawberry patches will serve to keep these diseases in check.

The diseases caused by nematodes may be avoided by planting strawberries in soil which is free from these pests. Infected land may be freed from nematodes by a three-year rotation with immune crops.

Fruit rots may be reduced by proper mulching. Careful handling and adequate refrigeration will greatly lessen the losses from rots which occur after picking.

Washington, D. C. Issued August, 1925

STRAWBERRY DISEASES

By NEIL E. STEVENS, *Pathologist, Office of Fruit-Disease Investigations, Bureau of Plant Industry*

CONTENTS

	Page		Page
Leaf diseases	2	Fruit rots	8
Leaf-spot	2	Gray-mold	8
Scorch	3	Tan-rot	9
Control of leaf-spot and scorch	3	Leather-rot	9
Leaf blight	5	Hard-rot	9
Mildew	5	Leak	10
Diseases caused by nematodes	6	Control of fruit rots	10
Nematode gall	6		
Root-knot	6		

STRAWBERRIES are more widely grown in the United States than any other small fruit. Not only is the strawberry particularly adapted to the home garden and found to some extent in such gardens in every State, but centers of commercial production are located in many widely different regions throughout the country. From these large centers of production fresh fruit is distributed over a period of more than six months each year. The growth of this fruit in so many different regions under widely different conditions has resulted in the development of special cultural methods particularly adapted to local requirements, and the locations of the growing centers with reference to the markets served have given rise to somewhat different handling and shipping practices.[1]

The strawberry is not only the most widely grown of small fruits, but is also the most important. The crop of 1924, for example, was more than 266,000,000 quarts, grown on about 146,750 acres.[2] The farm value of this crop was over $35,000,000. (Fig. 1.)

The number of varieties of strawberries grown in this country is large. Although about 50 varieties (see Farmers' Bulletin 1043) may be considered of commercial importance, experimental testing plats often contain several hundred. New varieties are grown from seed with ease, and plants of several new varieties are offered to the trade each season.

---

[1] Darrow, G. M. Everbearing strawberries. U. S. Dept. Agr., Farmers' Bul. 901, 20 pp., illus. 1917.
More, C. T., and Truax, H. E. Preparation of strawberries for market. U. S. Dept. Agr., Farmers' Bul. 979, 27 pp., illus. 1918.
Darrow, G. M. Strawberry culture: South Atlantic and Gulf coast regions. U. S. Dept. Agr., Farmers' Bul. 1026, 40 pp., illus. 1919.
——— Strawberry culture: Western United States. U. S. Dept. Agr., Farmers' Bul. 1027, 29 pp., illus. 1919.
——— Strawberry culture: Eastern United States. U. S. Dept. Agr., Farmers' Bul. 1028, 51 pp., illus. 1919.

[2] Statistics of truck crops, 1921–1924. *In* U. S. Dept. Agr., Crops and Markets, v. 1, Mo. Sup., p. 415. 1924.
Darrow, G. M. Strawberry varieties in the United States. U. S. Dept. Agr., Farmers' Bul. 1043, 36 pp., illus. 1919.

In view of the extent of strawberry culture in this country, the different conditions under which the crop is grown, and the number of varieties cultivated it is obvious that strawberry diseases will vary in importance in different sections. Consequently, few general statements as to the severity of a given disease or the resistance to disease of strawberry varieties can be made with the expectation that they will be everywhere equally applicable. Methods of control must also be adapted to local conditions. What is undertaken in this bulletin is to describe the more important strawberry diseases and to give an account of such control methods as are of proved value.

LEAF DISEASES

The diseases here grouped under the general term "leaf diseases" will sometimes be found to affect other parts of the plant. Leaf-spot

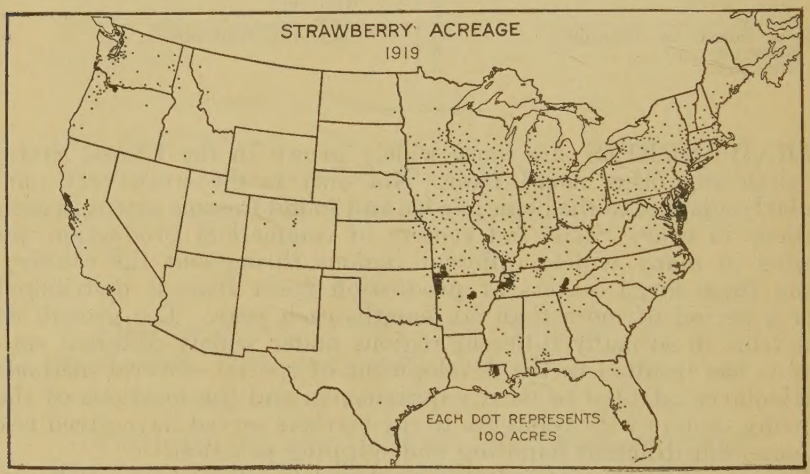


FIG. 1.—Outline map of the United States, showing the acreage of strawberries in 1919 according to the census of 1920, each dot representing 100 acres. (From A Graphic Summary of American Agriculture, Yearbook of the Department of Agriculture, 1921)

and scorch often occur on fruitstalks and mildew on the young fruit. They are most common and conspicuous, however, on the leaves.

LEAF-SPOT[3]

One of the most widely distributed and best-known diseases of strawberries, leaf-spot, as its name indicates, is usually confined to the leaves. When the spots caused by the disease first appear they are of a reddish or purplish tint, but as they increase in size the center of each spot becomes paler and finally gray or almost white. A typical fully developed spot is about an eighth of an inch in diameter and has a dead white center surrounded by a distinct reddish or purplish border, which finally merges into the color of the healthy leaf (fig. 2). The spots are scattered irregularly over the surface of the leaf and often become so numerous as to cause the death of a

[3] Caused by *Mycosphaerella fragariae* (Tul.) Lindau.

large portion of the leaf and in extreme cases even of the plant. Usually, however, the injury due to this disease is chiefly that of weakening the plant and reducing the crop through the loss of needed leaf surface.

SCORCH [4]

Scorch is almost as common on strawberries in this country as leaf-spot, for which disease it may be mistaken in the early stages, when the spots or blotches, usually purplish in color, are irregular in outline and vary in diameter from one-twentieth to one-fifth of an inch (fig. 3).

The diseased areas gradually enlarge, and many of them grow together. In severe cases the whole leaf may become purplish or reddish in color. Soon, however, the leaf margins become dry

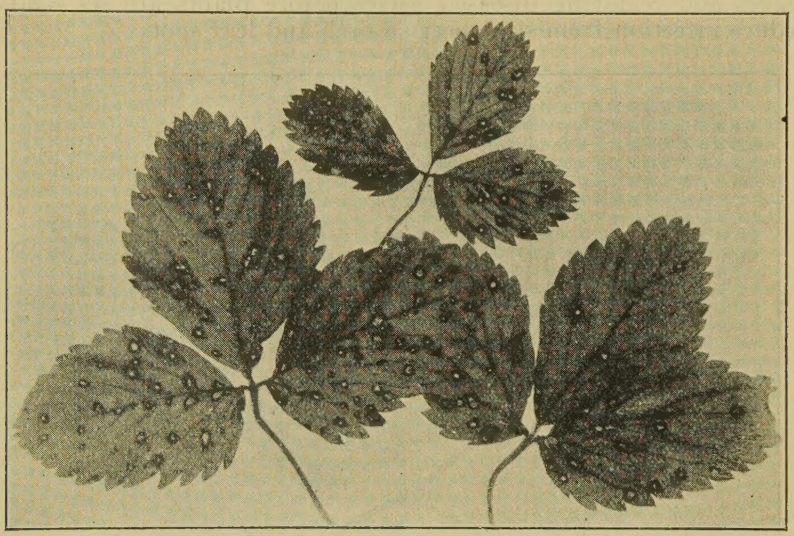


FIG. 2.—Strawberry leaf-spot. (Photographed by Stoddard)

(fig. 4) and have the burned or scorched appearance which has given rise to the name of the disease.

In case of severe infection entire plants may be killed or so weakened as to be worthless. One type of injury caused by this disease that results in large losses is the infection which often occurs on the fruit stalks, sometimes girdling them and thus causing the death of the flowers and young fruit.

CONTROL OF LEAF-SPOT AND SCORCH

That leaf-spot can be controlled by spraying with Bordeaux mixture has been known for at least 30 years. Recent experiments by the Connecticut and North Carolina Agricultural Experiment Stations have demonstrated that scorch may also be controlled by this method.

---

[4] Caused by *Mollisia carliana* (E. and E.) Sacc. (*Diplocarpon carliana* (E. and E.) Wolf).

It has been found most satisfactory for the control of leaf-spot and scorch to spray with 4–4–50 Bordeaux mixture as soon as growth is well started in the spring—that is, when the first leaves are about half grown—and to repeat the treatment as often as may be necessary to keep the foliage well covered until the first berries are about one-third grown. It may be necessary to spray as often as every 10 days. Usually one or two additional applications in the late summer will result in much better control.

Whether spraying should be undertaken in any particular case must be decided by the individual grower, taking into consideration its cost and the probable extent of the loss from these diseases. Often it proves more economical merely to reduce the diseases so far as is practicable by frequent renewal of strawberry patches and by reducing the chances for infection. Mowing off and burning old leaves and removing diseased leaves before plants are set tend to reduce infection from strawberry scorch and leaf-spot.

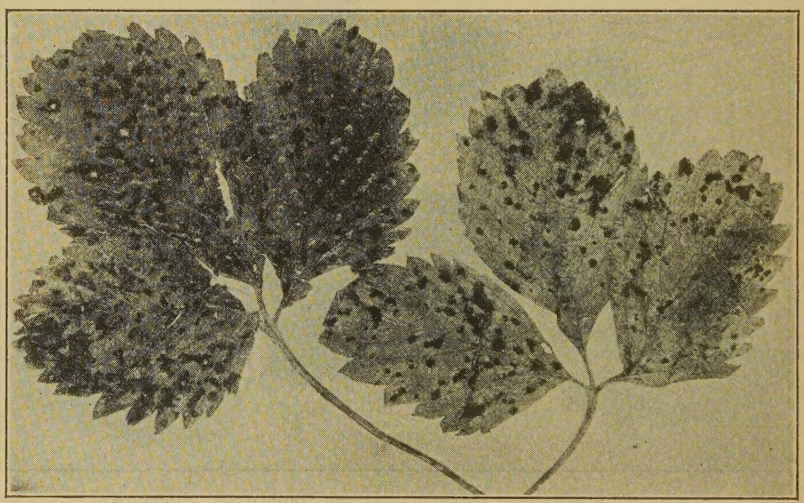


FIG. 3.—The "spot" stage of strawberry scorch. (Photographed by Wolf)

It is wise also to avoid setting any varieties which appear particularly susceptible to these diseases in a given locality. Lists of strawberry varieties which have proved very susceptible or resistant to certain diseases have been published at various times. These come from different workers and are frequently contradictory, the fact being, of course, that a variety may be obviously susceptible in one place or in one season and almost free from disease in another place or during another year. Reliable information as to the relative susceptibility of different varieties to various diseases is very difficult to obtain, owing to the fact that in large strawberry-growing sections one or two varieties are likely to be grown to the exclusion of others, and experimental plats usually contain only a relatively few plants of any given variety and are often maintained for only a few years. In order to secure reliable information on this point it would be necessary to carry on extensive comparative tests of the leading varieties in various sections of the country for a period of at least five or

six years. The wisest policy for the present will be for each grower to select varieties on the basis of local experience in the region.

LEAF BLIGHT[5]

Another disease which causes injury to strawberry leaves and leaf-stalks and has been found to be serious in Illinois and Michigan is angular spot, sometimes called blight. The dead areas caused by this disease even in the early stages are much larger than those made by leaf-spot. Usually there is only one injured region to a leaflet, although there may be three or four. In an advanced stage this disease is distinguished by the more or less triangular shape of the dead

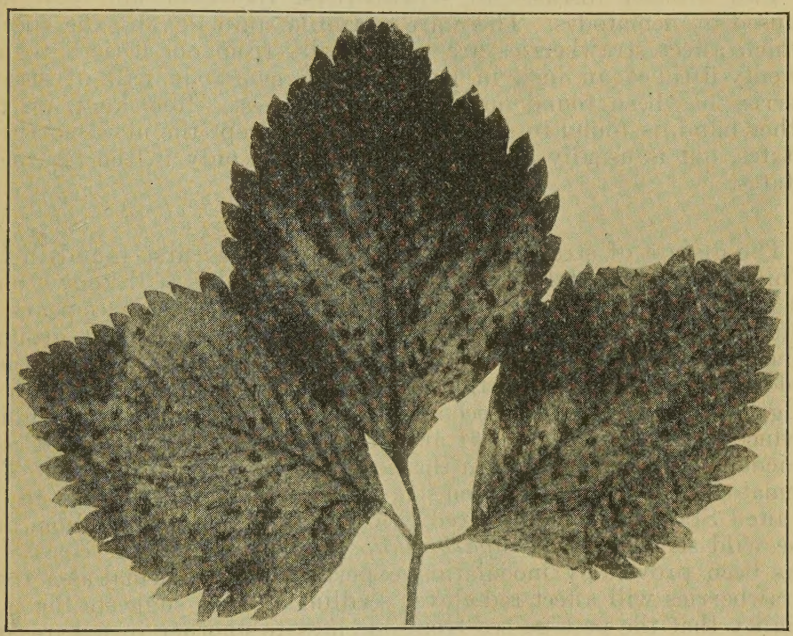


FIG. 4.—An advanced stage of strawberry scorch. The leaves have begun to dry along the margins

area, which often extends from one of the larger veins to the side of the leaflet and includes all the leaf tissue between the edge of the leaflet and the vein.

MILDEW[6]

Mildew has long been recognized as a serious disease in England and is locally destructive in this country. The most conspicuous symptom of the disease is the curling of the leaves. The edges of the leaflets gradually turn upward until much of the under side is exposed. If the under side of a diseased leaf is closely examined it will be found to be covered with a whitish down composed of the causal fungus.

---

[5] Caused by *Dendrophoma obscurans* (E. and E.) H. W. And.
[6] Caused by *Sphaerotheca humuli* (DC.) Burr.

For the commercial control of strawberry mildew in this country the ordinary sanitary measures recommended for leaf-spot and scorch have usually proved sufficient. Recently, however, the New York (Geneva) Agricultural Experiment Station has demonstrated in the Hudson Valley that mildew may be practically eliminated even during seasons of severe infection by four applications of 85–15 lime-copper dust. The first application was made as the first buds were expanding in the cluster and the succeeding ones at intervals of about 12 days.

DISEASES CAUSED BY NEMATODES

Two distinct diseases of strawberries, root-knot and gall, are caused by nematodes. These are wormlike animals, and the species which affect strawberries are very small—from one-fiftieth to one twenty-fifth of an inch in length. The nematode gall of strawberries has been found only in the Northwest. Root-knot, on the other hand, is found to some extent in all except the more northern States, but is usually serious on strawberries only in the Southern States.

NEMATODE GALL[7]

The disease of strawberries known as gall was first found in the United States about 10 years ago in Oregon and is still known only in the northwestern part of the country. The disease appears to affect only those portions of the plant which are above ground. The plants, as a whole, are usually somewhat dwarfed and their color is of a lighter green than that of normal plants. As shown in Figure 5, affected leaves become wrinkled, swollen, and often much reduced in size. On the leaf and fruit stems are often formed conspicuous galls which contain the nematodes in great numbers. The nematode which causes gall on strawberries[8] is known to occur in the United States on hyacinth, red clover, alfalfa, false dandelion, and the wild strawberry (*Fragaria chiloensis*) of the Pacific coast. It has been proved by inoculation experiments that nematodes from strawberries will affect red-clover seedlings. This suggests the possibility that the pest passes from one host to another in nature and that it may be dangerous to plant strawberries in fields in which affected crops of red clover or alfalfa have been grown. For the present, however, the most necessary control measure is the obvious one of not planting strawberries which are infected or those which come from infected fields.

ROOT-KNOT[9]

As indicated by its name, the disease known as root-knot is characterized by swellings or enlargements of the roots. Usually root-knot produces no malformations on those parts of the plant which are above ground, and as a result it is frequently overlooked. If the roots of an infected plant are examined, however, the disease is usually readily detected. In severe cases great numbers of the finer

---

[7] Caused by the nematode *Tylenchus dipsaci* (Kühn) Bastian.

[8] Godfrey, G. H., and M. B. McKay. The stem nematode *Tylenchus dipsaci* on wild hosts in the Northwest. U. S. Dept. Agr. Bul. 1229, 9 pp., illus. 1924.

[9] Caused by the nematode *Heterodera radicicola* (Greef) Muell.

roots and many of the large roots are found to be much enlarged at various points. These swellings, which are caused by the nematodes within the roots, vary greatly in size and shape.

The extent of injury to strawberries due to root-knot is very difficult to estimate. Relatively few strawberry fields in the older grow-

FIG. 5.—Nematode gall of strawberry. (Photographed by Byars)

ing regions of the South are free from root-knot, and the reduced yield due to the disease has come to be taken as a matter of course. Often, however, the disease becomes serious enough to cause the death of part of the plants and can no longer escape notice.

Control.—When available, new land or land known to be free from the root-knot nematode should be used for strawberries. In-

fected fields, however, may be largely freed of infection by a three-year rotation with crops which are immune to this nematode.

The following plants are known to be immune or only slightly susceptible to root-knot.

Barley.
Beggarweed.
Broomcorn millet.
Chufa.
Corn.
Cowpea (Brabham, Iron, Monetta, and Victor varieties).
Grasses (nearly all).
Kafir.
Milo.
Natal grass.
Peanut.
Pearl millet.
Redtop.
Rye.
Sorghum.
Soybean (Laredo variety).
Timothy.
Velvetbean.
Wheat.
Winter oats.

A full description of the root-knot nematode, its characteristics on various hosts, and the known methods of control are given in Farmers' Bulletin 1345.[10]

FRUIT ROTS

Fruit rots of strawberries, both on the plant and after the berries are picked, are caused by a variety of diseases, some of which are now known only in certain localities. In discussing each disease the region in which it is known to be serious will be indicated. This does not mean, of course, that the disease does not occur in other places; indeed, it is highly probable that many of these rots will be found in regions widely separated from those in which they are now known.

GRAY-MOLD [11]

The best-known and most widely distributed fruit rot of strawberries is that caused by gray-mold. This disease affects both green and ripe berries. The rot usually starts in the part of the berry which is next to the ground or touches another berry or a leaf. It is first noticed as a light-brown rather soft spot. The rot spreads in all directions through the berry and is not localized in any particular portion. After the berry is wholly rotten it soon begins to dry out and becomes firm and tough and of a uniform brown color throughout. At this stage the berry becomes almost entirely covered by a fine gray powdery or dusty appearing fungous growth, the well-known gray-mold. This disease is most common in the cooler strawberry-growing regions. It is often very destructive in Maryland, Delaware, New York, and New England, where it is not unusual for 10 per cent or more of the crop to be lost. The disease is especially favored by moisture and may become destructive in any of the large strawberry-growing sections during continued wet weather.

The growth of gray-mold can not be entirely prevented by refrigeration. Under the conditions found in many refrigerator cars strawberries affected with this disease often become covered with an abundant growth of soft, fluffy gray mold, which is very conspicuous and seriously hurts the sale of the entire load. Consequently it is important that berries affected with gray-mold be carefully culled out during picking and packing.

---

[10] Godfrey, G. H. Root-knot: Its cause and control. U. S. Dept. Agr., Farmers' Bul. 1345, 27 pp., illus. 1923.

[11] Caused by *Botrytis* sp.

The injury caused by gray-mold is not confined to the fruit. The blossoms are frequently blighted by this disease, and under favorable conditions leaf and flower stalks may be infected and the whole plant thus seriously injured.

TAN-ROT [12]

The so-called tan-rot is important, especially during rainy seasons, in Louisiana, Florida, Arkansas, Virginia, Maryland, and North Carolina. It may attack either green or ripe berries, forming slightly sunken tan-colored areas, which usually develop on the side of the berry. The rot extends into the pulp, so that the rotten portion forms a cone with its base at the surface of the berry. The outer layer of this diseased area becomes soft, and as the core of the rotten portion is held together by the rot fungus it is easily removed intact with the point of a knife or pencil. This characteristic serves to identify this trouble readily.

LEATHER-ROT [13]

Leather-rot, which has been found in Louisiana, Mississippi, Arkansas, Missouri, Tennessee, Kentucky, and Illinois, is readily distinguished from other fruit rots by the bitter taste of berries even slightly rotted. This disease may affect either ripe berries or green ones in any stage of development. When green berries are affected, all parts become dark brown over the affected areas or brown at the edges, shading off into the natural green. Partly colored berries show the same light-brown color at the center, but the spot shades off into purple and finally to the red of the berries. If a berry affected with this disease is cut across, a marked browning of the vascular strands is readily noted. This is usually accompanied by a less marked browning of the other tissues. At no time is there any clear line separating the diseased and the healthy flesh, nor can the diseased portion be easily removed, as in the case of tan-rot. The disease is most noticeable after rainy periods, especially if the weather is warm. Leather-rot has proved very serious during recent years in White County, Ark., and in Tennessee. During some years more than one-fourth of the crop has been lost.

HARD-ROT [14]

Hard-rot is known to be serious in the strawberry fields of central Florida, and it has been found in North Carolina, Arkansas, and Tennessee. As the rot is caused by a soil fungus it almost always occurs on the side of the berry which comes in contact with the soil, and a small quantity of soil will usually be found clinging to the decayed spot.

The affected berries are generally one-sided and show a hard brown rot, separated from the sound portion of the berry by a distinct line. The portion of the berry not actually penetrated by the rot fungus remains unchanged both in appearance and in taste.

---

[12] Caused by *Pezizella lythri* (Desm.) Shear and Dodge.
[13] Caused by *Phytophthora cactorum* Leb. and Cohn.
[14] Caused by *Rhizoctonia* sp.

LEAK [15]

The most common and destructive rot of strawberries in transit and on the market is that almost universally known as leak. As its name indicates, this rot is characterized by the collapse of the berry and the loss of much juice. It is not uncommon for the juice to drip from boxes and crates of badly infected fruit. The black-mold destroys strawberries more rapidly than any other fungus now known, and it is almost always present in packing sheds and on the markets.

Fortunately this mold usually gains entrance to the berry through wounds and grows very slowly at temperatures below 50° F. The rate of growth increases very rapidly, however, with the rise of temperature above this point. Occasionally, especially under conditions of extreme moisture, leak appears as a field rot.

CONTROL OF FRUIT ROTS

The field rots of strawberry fruits, particularly gray-mold and leather-rot, are most abundant during wet weather. Well-drained patches in which rain water does not stand between the rows after each shower usually suffer less from fruit rots. In the same way patches which are largely free from weeds and therefore dry out more quickly after rains are usually less subject to these diseases. A useful sanitary measure and one followed by many progressive growers is to pay pickers for boxes of culls at the same rate as for good berries. This practice not only serves to get rid of the rotten berries which scatter infection to sound fruit but removes the temptation for pickers to put decayed berries in the boxes with good ones.

Mulching tends to reduce fruit rots. Spraying has been tried with some indication of success but can not as yet be confidently recommended.

All rot fungi are favored by high temperatures. Although gray-mold can not be entirely checked by any degree of refrigeration which will not injure the fruit itself, even this rot grows much more slowly at low temperatures. It is therefore of first importance that berries which are to be kept for some time or shipped long distances should be cooled as quickly as possible and kept cool until they reach their destination. A useful aid in accomplishing this and one that has proved most advantageous in practice is to pick as large a part of the crop as possible early in the day while it is still cool. Most rot fungi, particularly black-mold, usually gain entrance to the berry through injuries. Careful handling in picking, packing, and loading is absolutely necessary if severe loss from rot is to be prevented. When practicable, as when most of the picking is done by the grower's family or by experienced help, the berries may be sorted as picked. This eliminates rehandling in packing and is probably the most desirable procedure.

---

[15] Caused by the common black-mold, *Rhizopus nigricans* Ehrb.

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY